EPA Comments on the Draft GWET System Effectiveness Evaluation
Former Arkema, Inc. Facility, Portland, Oregon
Dated September 2018

Comments dated October 24, 2018

The following are the U.S. Environmental Protection Agency's (EPA's) comments on the September 2018 document titled *Draft GWET System Effectiveness Evaluation, Arkema Inc. Facility, Portland, Oregon* (Report) prepared by ERM-West, Inc. (ERM) on behalf of Legacy Site Services LLC. The Former Arkema Inc. Facility (site) is listed in the Oregon Department of Environmental Quality Environmental Site Cleanup Information database as number 398, with a high priority for groundwater pending effectiveness of source control measures.

EPA's comments are presented in the following sections. Comments are separated as: "Primary," which identify concerns that must be resolved to achieve the assessment's objective; "To Be Considered," which, if addressed or resolved, would reduce uncertainty, improve confidence in the document's conclusions, and/or best support the assessment's objectives; and "Matters of Style," which substantially or adversely affect the presentation or understanding of the technical information provided in the report.

***** Comments followed by an asterisk denote that the change requested by EPA must also be addressed in Section 8 Conclusions.

Primary Comments

1. General Comment: The Report lacks detailed explanation and supporting information for statements made about the effectiveness of the groundwater extraction and treatment system (GWET) and hydraulic containment of the site contaminants of concern (COCs). These statements need to be reviewed alongside empirical data to comment on their technical validity. Additionally, the empirical data that is provided in the Report are not fully developed as per Section 2 of the Performance Monitoring Plan (PMP) (ERM 2014) and the PMP-referenced Evaluation of Capture Zones guidance document (EPA 2008). For example, water level difference maps and gradient calculations are not performed to assess the vertical groundwater gradient at the site (PMP Section 2.2.1); conclusions drawn from the potentiometric surface maps (Report Appendix A) do not take into account the tidal fluctuations of the Willamette River enhancing or obscuring site groundwater gradients (PMP Section 2.2); and empirical pumping test data used to update the groundwater model are not included or discussed in the Report (PMP Section 2.3). Therefore, EPA is unable to perform a complete review of the Report until detailed explanation and additional supporting information, as noted in the following comments, is provided.

2. Section 1 Introduction, page 1, paragraph 2: This section references improvements to the GWET that were proposed in the June 10, 2016 Corrective Action Plan (CAP) (ERM 2016a) and the November 21, 2016 Updated CAP Response Letter (ERM 2016b). However, no references were made to the 2017 GWET Enhancement Work Plan (ERM 2017) which details steps to increase the overall groundwater extraction rate of the GWET. Additional information must be provided detailing which activities proposed in the GWET

Enhancement Work Plan were completed as planned, which activities were not completed, and any deviations from the work plan that occurred.

3. Section 3.1 Groundwater Treatment and Solids Management, page 6, paragraph 4*: The Updated CAP Response Letter (ERM 2016b) stated that Coagulant M-1883 and an anionic polymer were selected as the "most effective precipitation chemistry tested to date." However, the Report states that an aluminum-based coagulant and two different polymers are now being added to the treatment process. Specific details on the coagulant and polymers being used, the rationale and supporting evidence for their selection, and how the treatment process differs from what was presented in the Updated CAP Response Letter (ERM 2016b) must be provided.

4. Section 4 Groundwater Elevations, page 11*: The data provided in the Report do not support the conclusion that Shallow Zone groundwater is not travelling around the north end of the groundwater barrier wall (GWBW). This statement must be revised to accurately reflect site data or be removed from the Report. According to Figures 1, A-1, and A-4, Shallow Zone groundwater immediately to the north of the GWBW (extending to the stormwater detention basin and sand filter) exhibits a steep hydraulic gradient towards the Willamette River, and may provide a pathway for COCs in the Shallow Zone aquifer to the Willamette River. The steep hydraulic gradient towards the Target Capture Boundary is only present in the Shallow Zone and only extends beyond the GWBW approximately to the location of the piezometer PA-03. Additionally, the absence of any monitoring wells between the western boundary of the site and the north end of the GWBW (approximately 800 feet [ft] away) call into question the validity of conclusions drawn from the potentiometric surface maps presented in Appendix A.

5. Section 7 Model Results*: The site groundwater model was originally developed to support the design and installation of the GWET and GWBW (ERM 2007). Based on the limited information provided in the Report, EPA is unable to perform a complete review of the updated model and its results. To provide a complete review, an updated water balance equation (reflecting the updated boundary conditions) along with updated hydraulic properties, zones of recharge application, and model calibration methods and results must be provided. This information is required to determine if the model is suitable for the new purpose of estimating the effectiveness of the GWET at capturing the COC plumes. At this time, the results and conclusions drawn from the GWET capture zone simulations cannot be verified for accuracy or completeness and are considered by EPA to be incomplete. Additionally, to properly assess capture of the COC plume in the Shallow Aquifer, the particle tracking analysis must be performed in the plume area extending to the north of the GWBW.

To Be Considered Comments

1. Section 3.1 Groundwater Treatment and Solids Management, page 7*: The Report states that the GWET has managed sustained flows greater than 50 gallons per minute (gpm) without treatment capacity issues and is capable of treating flows in excess of 65 gpm. Additionally, it is stated in this section that the limiting factor of the GWET system is sludge

dewatering capacity. Additional explanation and relevant supporting data should be provided to validate these statements.

2. Section 4 Groundwater Elevations, page 12, paragraphs 2 and 3*: No information is provided to support the statement that a downward vertical gradient is present between the Shallow to Intermediate and Intermediate to Deep Zones. While this may be accurate, calculations should be provided, or the statement should be revised to clarify that a downward vertical gradient may exist at the site.

3. Section 4 Groundwater Elevations, page 12, paragraph 4*: The discussion provided in this paragraph conflicts with the conclusion that site stratigraphy limits the depth to which water can be pumped in the Shallow Zone. If the elevations of the base of the Shallow Zone range from approximately 0 to 6 ft based on the North American Vertical Datum of 1988 (NAVD88), then groundwater elevations at 8 ft NAVD88 would not be below the bottom of the Shallow Zone but rather above it and theoretically available for pumping and treatment by the GWET. It is possible that the values presented in this paragraph are depths to water rather than elevations, in which case the conclusion about groundwater availability would be accurate. This paragraph should be revised to clarify the vertical reference and/or datum used and/or the conclusions drawn about groundwater availability in the Shallow Zone.

4. Section 5 GWET Wells Extraction Rates and Relationship with Seasonal Conditions, page 13 and Table 1*: The data provided in Table 1 do not show a clear seasonal fluctuation in GWET system extraction rates. The months used to demarcate the seasonal differences (i.e., dry and wet seasons) should be defined in this section and the average extraction rates for these different periods should be provided as supporting evidence. Additionally, data prior to July 2017 should be provided as a long-term record of extraction rates, and the reason for defining the hydrologic year as July 1 to June 30 should be explained. The United States Geological Survey (USGS) defines the hydrologic year as October 1 to September 30 (USGS 2016).

5. Section 6.2 Modeling Approach to Simulate GWET Capture Zones Under Different Seasonal Conditions, page 19 and Table 1: The GWET pumping conditions for Scenario 3 (average season conditions) were set to the average flow between June, July, and August 2018. The August 2018 flow data is not provided in Table 1, and the average monthly extraction rate for August 2018 would need to be 45.8 gpm to achieve the Scenario 3 extraction rate of 34.8 gpm (based on the June and July 2018 data in Table 1). It is possible that the flow conditions for this scenario were set to the average extraction rates from May through July 2018 (average of 34.4 gpm). However, since the seasonal high groundwater occurs in May and the highest average extraction rate occurred in May 2018 (44.6 gpm), this month doesn't represent average conditions and instead represents a seasonal high condition that possibly biases Scenario 3 results to indicate higher plume capture than is achievable under average conditions. The August 2018 average extraction rate data should be provided, and the Scenario 3 extraction rate should be revised.

Matters of Style Comments

1. Section 5 GWET Wells Extraction Rates and Relationship with Seasonal Conditions, page 13, paragraph 1: The statement about Willamette River stage serving as a proxy for background groundwater conditions over time should be clarified. More information is needed to support this statement.

2. Section 6.3.1 Willamette River, page 20: This is the first and only mention of "above mean sea level" as a vertical datum. The use of this datum should be clarified, or this section should be revised to reference the correct datum.

3. Figures:

    a. Figures 2, 3, and 4: Appropriate units should be added to the y-axis. For Figures 3 and 4, the overlain plots are difficult to read and a secondary axis on the right side of the figure should be used. Also, the vertical datum used to measure Willamette River stage should be specified.

    b. Figure 5: The location of the general head boundary (southern boundary) disagrees with Section 6.3.2 (northern boundary).

    c. Figures 6a through 9: Units should be added to the groundwater contours and the vertical datum being used to denote groundwater elevation should be specified.

    d. Appendix A: The figure numbers provided on the figures themselves do not match the PDF bookmarks. The figures should be revised for clarification, and the vertical datum being used to denote groundwater elevation should be specified.

References

EPA. 2008. *A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems.* Office of Research and Development. January.

ERM. 2007. *DRAFT Groundwater Modeling Report, Arkema Inc. Facility, Portland, Oregon.* December.

ERM. 2014. *Revised Final Performance Monitoring Plan – Groundwater Source Control Measure, Arkema Inc. Facility, Portland, Oregon.* July.

ERM. 2016a. *Corrective Action Plan Groundwater Extraction and Treatment System, Arkema Inc. Facility, Portland, Oregon.* 10 June.

ERM. 2016b. *Corrective Action Plan Update Groundwater Extraction and Treatment System, Arkema Facility Portland, ESCI #398*. 21 November.

ERM. 2017. *Re: Recovery Wellfield Enhancement Work Plan Groundwater Extraction and Treatment System, Arkema Facility Portland, ESCI #398.* 7 March.

USGS. 2016. Explanations for the National Water Conditions. 10 February. Accessed: September 13, 2018. https://water.usgs.gov/nwc/explain_data.html.

MEMORANDUM

Yakama Nation Fisheries

Columbia River
Honor. Protect. Restore.

OFFICE
P.O. Box 151
401 Fort Road
Toppenish, WA 98948

PHONE
(509) 985.3561

FAX
(509) 865-6293

EMAIL
shil@yakamafish-nsn.gov

WEB
Yakamafish-nsn.gov

Date: October 19, 2018

To: Matt McClincy, Oregon Department of Environmental Quality

From: Laura Shira, Environmental Engineer Laura K. Shira

RE: **Review of September, 2018, Draft GWET System Effectiveness Evaluation, Arkema**

Yakama Nation Fisheries has reviewed the above referenced document and submits the following comments. Our general impression was that the evaluation was open and clear regarding the issues with the system. The evaluation documented that many early problems have been identified and corrected and that the system is now running fairly routinely. A number of ongoing problems were also identified with plans being developed to correct them. However, we do have a few concerns.

1. Section 3.2.2. Mention is made that DNAPL fouled a couple of the well screens (ex. RW-7, RW-8), but the discussion did not go on to address to what extent DNAPL is present in the recovery area or whether there is a separate effort to capture the DNAPL. What efforts are ongoing or planned to address the DNAPL?

2. The report notes that with the present system it appears likely that the contaminated plume moves under the barrier wall to the river, at least under some flow conditions. The report modeling of revisions to the system to estimated approaches that can achieve full capture. These approaches rely on improving capture from the existing well, as well as possibly adding more recovery wells. Increasing capture in existing wells is largely dependent on improved techniques to reduce screen fouling. The fouling issue is being investigated, with a report expected in January 2019, that will explain the source(s) of the fouling and propose solutions, but neither the effectiveness of any new procedure nor estimated dates for implementation were made. Given this situation, monitoring of the sediments and porewater in the potential discharge zone in the river should be implemented (assuming that is not already being done). If other monitoring is already being done, than this document should also discuss these other lines of available evidence. The report mentions only groundwater elevation measurements in the ongoing groundwater plume monitoring program. In addition, an enforceable timeline is needed for implementing improvements required to provide a protective groundwater extraction and treatment (GWET) system in advance of in-water cleanup.

3. With the present system, the majority of the plume is captured by only three wells (Figure 2). It was expected that many wells would have low recovery and the increased-recovery plan discussed above includes improving recoveries in most wells. However, it seems that failure of one or more of those three key wells would have serious consequences, and it seems that as a minimum there should be clear plans to quickly correct any problems at these main wells. What are the contingency plans for well failures of any of these key wells?

4. Please describe source control efforts for the portion plume that extends to the north, beyond the capture zone of the containment wall (ex. Figure 6a).

A general discussion of the Arkema site would be helpful to schedule in an upcoming TCT meeting. We have questions regarding the status, upcoming schedule, and overall findings, concerns, and data gaps for both the upland, source control, and in-river efforts. We also request a summary of past and ongoing transport to the river and the ongoing monitoring program.

HydroAnalysis

TECHNICAL MEMORANDUM

To: Matt McClincy, Oregon Department of Environmental Quality (DEQ)

From: Peter Shanahan, HAI

Subject: Review of Draft GWET System Effectiveness Evaluation, Arkema Inc. Facility, September 2018

Date: October 19, 2018

ERM prepared a draft report on their evaluation of the effectiveness of the groundwater extraction and treatment (GWET) system in place since 2014 at the former Arkema facility in Portland, Oregon (ERM, 2018). The report was prepared for Legacy Site Services LLC and is dated September 2018. This memo summarizes the findings from our review of the report. This review has been prepared on behalf of the Five Tribes[1].

General Observations

This report contains several key flaws and omissions. Arkema is one of the more contaminated sites within the Portland Harbor Superfund Site and the measures taken to control contaminated groundwater on the site have been inadequate. The original intent of the groundwater source control measure (SCM) was to contain contaminated groundwater behind the groundwater barrier wall (GWBW) and extract it so that it never reached the river. As stated by ERM (2013): "One of the key measures of the performance of the groundwater SCM is the hydraulic gradient across the GWBW. By establishing an inward hydraulic gradient across the GWBW, a groundwater flux away from the Willamette River will be created." Section 4 of the system effectiveness evaluation (SEE) report however shows that the system has failed to establish the desired inward gradient: "Groundwater elevation differences between shoreline locations and the area immediately upland of the [GWBW] range seasonally from 8 ft in low groundwater conditions to less than 3 ft in high groundwater conditions. Groundwater elevation differences between the areas upland of the GWBW and the upgradient boundary locations are generally consistent between 13 and 14 ft in both low and high groundwater conditions" (ERM, 2018, pg. 11). Not stated in this description is the important fact that the "elevation differences" are from the inland side to the river side of the barrier wall—i.e., towards the river and opposite the desired hydraulic gradient. The failure to establish the desired gradient despite the fact there is on-going pumping suggests the barrier wall is failing to meet its objectives. ERM (2018, pg. 12) briefly mentions "that there is potentially some flow downwards and under the GWBW"

---

[1] The five tribes are the Confederated Tribes of The Grand Ronde Community of Oregon, the Nez Perce Tribe, the Confederated Tribes of Siletz Indians, the Confederated Tribes of the Umatilla Indian Reservation, and the Confederated Tribes of the Warm Springs Reservation of Oregon.

but fails to elaborate on this potentially significant failure. Further evaluation of the GWBW's effectiveness is needed and corrective action, such as grout injection to ensure the degree of capture originally intended, may be required.

Also of concern is the abandonment of recovery wells RW-7 and RW-8. These wells were reported by ERM (2016) to have been fouled by dense non-aqueous-phase liquid (DNAPL) (not stated but presumably monochlorobenzene (MCB) DNAPL). The Corrective Action Plan (CAP) (ERM, 2016, pg. 7) indicates that DNAPL recovery will be evaluated for these wells and the extraction enhancement work plan (ERM, 2017a, pg. 5) states that "Groundwater extraction at recovery wells RW-07 and RW-08 will be resumed following redevelopment of each of these two wells" with a target date of April 2017 in Table 2. In contrast, the SEE report simply reports that the wells have been fouled and are not being operated. This is problematic for two reasons. First, DNAPL constitutes a very persistent and strong source of groundwater contamination and thus should be a target of remediation. At a minimum, consideration should be given to converting RW-7 and RW-8 to DNAPL extraction wells, and replacing them with new groundwater extraction wells. Alternatively, the previously successful *in-situ* DNAPL treatment by persulfate should be revisited. Second, DNAPL has the potential to compromise the GWBW. Although this possibility was considered in the initial design of the barrier wall (ERM, 2010, pg. 14), the poor performance of the wall suggests that this issue should also be revisited. Regardless, leaving DNAPL in place can only prolong groundwater contamination on the site and the site's threat to the river.

The report's analysis of possible future performance is also inadequate. While the groundwater model results for Scenario 4 indicate full groundwater capture is theoretically attainable, ERM (2018, pg. 27) states "Site stratigraphy limits the amount of groundwater available for pumping in the dry season" and the final bullet item on page 28 and 29 indicates there is uncertainty whether full groundwater extraction is achievable. The SEE report wisely recommends a study to identify the root causes of fouling (ERM, 2018, pg. 30), but this necessarily implies more delay in achieving intended system performance. This study should be expedited and monitored closely by DEQ to ensure complete groundwater capture is achieved as soon as possible.

Section 9 of the report, the study recommendations, fails to commit to implementing measures that will achieve full capture. While well fouling is a vexing problem, installing more wells can compensate for poor well performance. In addition, alternative pumping techniques, such as a manifolded educator well system that could continue to withdraw water from the shallow zone even during low-water conditions, should be considered.

Finally, the report lacks several key pieces of information. As discussed above, the gradient across the GWBW is an important indicator of system performance and it is measured real-time across six well pairs on either side of the barrier wall (ERM, 2013, Figure 2-5). None of these important time-series data are provided or evaluated in the SEE report. Similarly, the SEE report and prior reports discuss the problems created by variable influent chemistry, but no data on influent water quality over time are included in the SEE report. Such data might reveal, for example, whether separate pre-treatment of influent from different areas of the site or flow equalization would allow for more effective treatment.

The SCM Performance Plan (ERM, 2013) provided for monthly reports on system performance, but only for one year. Given the continuing deficiencies in system performance, the ongoing corrections to system performance, and the failure of the SEE report to provide these data, a requirement for regular comprehensive reporting should be re-established.

Detailed Comments

The following bullets provide detailed comments on the DRAFT GWET System Effectiveness Evaluation (ERM, 2018).

- Section 3 – The complexity of the influent groundwater chemistry is mentioned in this section and discussed in more detail in prior reports, but the SEE report fails to provide data characterizing how the effluent varies over time and the causes of such variation. One would not expect the quality of groundwater from a single pumping well to vary rapidly or substantially; the variability in the influent would thus seem to stem from variation in the mixture of water from different wells. The report should include more discussion of the nature of the influent variation, the time scales over which it occurs, and the possible reasons for the variation. This type of analysis would potentially provide insight into measures that could be taken to improve treatment.

- Section 6.2 – The report makes reference to the "72-hour moving average method of Serfes (1991)." As pointed out in a prior review for another site, the Serfes method is neither a moving average nor a 72-hour average and was computed incorrectly by ERM at that site (Shanahan, 2016). ERM should provide a description of the method used at the Arkema site to ensure that it is being applied correctly.

- Sections 6.1 and 6.3 – The groundwater model is an important tool in planning corrective actions but the description in these sections raises the following questions:

    - The description of the groundwater model neglects to describe how the GWBW is represented in the model. This is an important feature of the model and should be described in detail.

    - Page 11 of the report provides a description that implies that shallow groundwater north of the GWBW is influenced by the stormwater detention basin and sand filter in Lot 3. If the basin and filter bed are unlined, they would be expected to raise the underlying groundwater level and thus affect groundwater flow. This should be represented in the model by increased recharge rates that reflect the infiltration, if any, at these structures.

    - The southeast boundary of the model is inappropriately close to the area of interest in the model and there is no obvious reason to truncate the model at that location. The model should be expanded to the southeast to ensure a solution that is not unduly influenced by a proximate artificial general-head boundary condition.

- The river is represented by a constant-head boundary condition whereas USEPA (2015) reports that river bottom sediment varies spatially. A river boundary condition that reflects the impedance created by fine-grained bottom sediment would be more appropriate.

- The model has been substantially modified since the Groundwater Modeling Report was submitted in 2007 (as reported by ERM, 2018). An updated report on the model should be provided since the model is an important component of the work going forward.

Cited Documents

ERM, 2010. Preliminary Design Report – Groundwater Source Control Measure, Arkema Inc. Facility, Portland, Oregon. Prepared for: Legacy Site Services LLC. Environmental Resources Management, Portland, Oregon. May 2010.

ERM, 2013. Final Performance Monitoring Plan – Groundwater Source Control Measure, Arkema Inc. Facility, Portland, Oregon. Prepared for: Legacy Site Services LLC. Environmental Resources Management, Portland, Oregon. August 2013.

ERM, 2016a. "Corrective Action Plan, Groundwater Extraction and Treatment System, Arkema Facility Portland, ESCI #398." Letter from Brendan Robinson, P.E., and Erik C. Ipsen, P.E., Environmental Resources Management, to Matt McClincy, Oregon Department of Environmental Quality. Environmental Resources Management, Portland, Oregon. November 21, 2016.

ERM, 2016b. "Corrective Action Plan Update, Groundwater Extraction and Treatment System, Arkema Facility Portland, ESCI #398." Letter from Brendan Robinson, P.E., and Erik C. Ipsen, P.E., Environmental Resources Management, to Matt McClincy, Oregon Department of Environmental Quality. Environmental Resources Management, Portland, Oregon. November 21, 2016.

ERM, 2017. "Recovery Wellfield Enhancement Work Plan, Groundwater Extraction and Treatment System, Arkema Facility Portland, ESCI #398." Letter from Brendan Robinson, P.E., Environmental Resources Management, to Matt McClincy, Oregon Department of Environmental Quality. Environmental Resources Management, Portland, Oregon. March 7, 2017.

ERM, 2018. DRAFT GWET System Effectiveness Evaluation, Arkema Inc. Facility, Portland, Oregon. Prepared for: Legacy Site Services LLC. Environmental Resources Management, Portland, Oregon. September 2018.

Serfes, M. E., 1991. Determining the mean hydraulic gradient of ground water affected by tidal fluctuations. *Ground Water*. Vol. 29, No. 4, Pg. 549-555. July-August 1991.

Shanahan, P., 2016. "Review of Draft Performance Monitoring Plan–Groundwater Source Control Measure, Premier Edible Oils, Portland, Oregon, March 2016." Technical Memorandum from Peter

Shanahan, HydroAnalysis, to Erin McDonnell and Matt McClincy, Oregon Department of Environmental Quality. HydroAnalysis, Inc., Acton, Massachusetts. April 1, 2016

USEPA, 2015. Portland Harbor RI/FS Remedial Investigation Report, Appendix C2, Groundwater Pathway Assessment and Geochemical Analysis, Draft Final. U.S. Environmental Protection Agency, Region 10, Seattle, Washington. June 12, 2015.